PRESS SECTION TAIL THREADING

FIELD OF THE INVENTION

The present invention relates to the threading of a travelling paper web or strip through process machinery for forming the paper web. More specifically, the present invention relates to a method of and an apparatus for threading a "tail" of the web from one press nip to another in the press section or to a subsequent drying section of a papermaking or boardmaking machine.

BACKGROUND OF THE INVENTION

The papermaking and boardmaking industries have made significant advancements in recent years. Specifically, operating speeds have significantly increased, despite the fact that safety and operating regulations have become more stringent. Thus, as speed and technology advancements drive production costs lower, it will become clear to those in the art that the cost of delay in bringing a machine up to operating speed after a web break becomes more significant. This is particularly true in the press section of a papermaking or boardmaking machine, where the fibrous web is relatively wet and sticky compared to downstream locations, such as the drying section of the machine.

Conventional methods and machines for threading a tail portion, i.e., a narrow portion sometimes referred to as a strip, of a fibrous web involve either manual, semi-manual, or other labor intensive steps and machinery. These techniques are difficult to perform since the web is relatively wet and difficult to handle. Thus, there is a longfelt need for an apparatus that is capable of quickly and easily threading a fibrous web in a press section of a papermaking or boardmaking machine automatically by way of the tail of the fibrous web from one press nip or roll to another press nip or roll in the press section of the machine or to a nip or roll in the downstream drying portion of the machine.

A prior apparatus for guiding a travelling paperboard tail from the press section to the drying section or between presses of a boardmaking machine is disclosed in U.S. Patent No. 6,131,784 to Helgesson et al. According to the '784 patent, the board tail is loosened and lifted up from the upper surface of a press fabric by means of air jets. A curved transfer member is provided above the press fabric and arranged to lift the board tail and deflect it into a gap formed between a drying fabric and a dryer can or rope nip. The transfer member comprises several elongate air supply tubes extending in the cross-machine direction substantially parallel and close together. The air supply pipes have a plurality of holes or nozzles facing downstream using the Coanda effect so as to produce an even air flow without producing turbulence along the side adjacent the board tail. The transfer member is movable or fixedly mounted in the cross-machine direction from a non-operating position outside the edge of the press fabric to an operating or threading position above the run of the board tail. While the apparatus of the '784 patent is directed to both relatively dry and relatively wet webs, a web that is substantially wet may be too heavy to be lifted by the transfer member of the '784 patent.

Another conventional apparatus for guiding a travelling paper tail through sections of a papermaking machine is disclosed in U.S. Patent No. 4,692,215 to Kerttula. According to the '215 patent, a paper tail is scraped loose from the surface of a press roll by means of a doctor blade. An air jet from a beam supporting the doctor blade impacts the tail and blows the tail into a bag- or sack-like shape. The downwardly hanging portion of the bag is cut by suitable equipment to create a leading end of the tail. The tail is then conveyed onwards on top of an endless air-permeable conveyor belt running in a loop around a device for creating a subatmospheric pressure that sucks the tail against the belt. Upon reaching the downstream end of the conveyor, the suction is relieved and air jets loosen the tail from the belt so that the leading end of the tail is transferred into a nip formed between a dryer can and a drying fabric. The apparatus of the '215 patent is not suitable for a web travelling through the press portion of a papermaking machine, however, because of the relatively high weight and moisture content of the web, particularly if the web is formed from board instead of paper. Specifically, a web travelling through the press section of a papermaking or boardmaking machine is heavy

and hard to handle so that it would be very difficult or impossible to blow into a bag as described by the '215 patent.

Yet another conventional apparatus for transferring a travelling paper tail between dryer cans of respective dryer groups in the drying section of a papermaking machine is disclosed in European Patent Application No. 674,045. There, a paper tail is scraped loose from the surface of a roll or dryer can by means of a doctor blade so that the tail hangs substantially straight down. A planar guide plate is pivotally mounted near the doctor blade so that the guide plate can be pivoted to a substantially horizontal position. Air jets near the pivot of the guide plate force air along the upper surface of the guide plate that draws the running tail close to the guide plate. When the guide plate is pivoted to the horizontal position, the downstream end of the guide plate passes close to an upstream edge of a subsequent, fixed second guide plate so that the paper tail is cut off and the newly-created leading end of the tail is transferred over the second guide plate by air jets at the trailing end of the first guide plate. The tail is then conveyed onwards into a gap or nip between a drying fabric and the first dryer can of the subsequent dryer group. The apparatus of the '045 application requires a relatively dry web, however, that can be moved along the length of the guide plate by the air jets located at the pivot end thereof.

As stated above, conventional web threading methods and machines used for tail threading in the drying section of a papermaking or boardmaking machine may not be usable in the press section because of the differences in the structure of the web at the locations where tail threading is desirable. In a boardmaking machine, for example, the press section may include three presses, and a tail threading device may be provided after the second press for transferring the tail to the third press, and/or after the third press for transferring the tail to the drying section. After the second press, the web is still comparatively wet, i.e., the web has a dryness level of about 30 percent. Such a wet web is heavy, tends to adhere to adjacent surfaces of the machine, and breaks easily.

By contrast, a tail in a drying section of a papermaking or boardmaking machine has a much higher level of dryness. In particular, the first tail threading device in a drying section usually is provided after a first group of dryer cans, such as about 20 cans. A web reaching this location has been dried to about a 60 percent level of dryness, which gives the web a different structure and much improved strength properties over the

relatively wet web in the press section of the apparatus. The relatively high dryness level facilitates handling of the web - the web no longer has a pronounced tendency to stick to adjacent machine surfaces, and it is relatively easy to carry the web forward by air jets. In addition, the strength of the web is such that a cutting mechanism is typically required to cut the web to form the tail to be threaded through the drying section of the machine.

Conventional papermaking and boardmaking machines such as those described above include threading devices that are directed toward a much dryer web, such as webs found in a drying section of a papermaking or boardmaking machine. Therefore, it is desirable to provide a device or apparatus for threading a relatively wet web like that found in the press section of a papermaking or boardmaking machine between press rolls or nips to subsequent rolls or nips, or to downstream drying sections of the machine.

SUMMARY OF THE INVENTION

The present invention is directed towards an apparatus for a wet and/or press section of a machine for making a fibrous web. Advantageously, the apparatus is designed for threading a relatively wet web through the press section of the machine without damaging the web. In this regard, the apparatus provides for the transfer of the broken end or tail of the fibrous web through the press section of the machine.

In particular, the apparatus comprises a first transfer device positioned in the press section of the machine for dewatering a wet fibrous web, wherein the web exiting the first transfer device is relatively wet. In this regard, the fibrous web exits the first transfer device with a relative dryness of no more than about 60%, and preferably about 20-50%. The first transfer device includes a roll over which the fibrous web travels and may also include a cutting device, such as a movable cutting blade, to cut the tail of the fibrous web. The apparatus also includes a second transfer device positioned downstream of the first transfer device to receive the fibrous web directed from the first transfer device. The second transfer device, which in one embodiment includes a transfer zone formed between a paper guide roll and a suction transfer roll, is spaced from the first transfer device such that a gap is defined therebetween. Further, the second transfer device may be positioned in the drying section of the machine, although preferably the second transfer device is also located in the press section of the web making machine.

The apparatus also includes a threading device positioned in the space defined by the first transfer device and the second transfer device. The threading device includes a stationary upper surface over which the tail of the fibrous web travels during the threading operation from the first transfer device to the second transfer device. The threading device includes a plurality of tubes that, according to one embodiment, extend substantially transverse to the path of travel of the fibrous web. The tubes preferably have a substantially rectangular shape, and each tube defines an outlet for discharging air along at least a portion of the upper surface of the threading device so as to provide an air cushion between the upper surface of the threading device and the fibrous web. In this regard, the fibrous web tends to follow the upper surface of the threading device to the second transfer device, where the web is threaded thereinto. In one embodiment, at least one of the plurality of tubes of the threading device defines a plurality of openings for discharging air. The openings defined by the tubes may be staggered in a direction substantially transverse to the path of travel of the fibrous web, although in one embodiment the openings of the tubes are aligned in both the transverse direction and the path of travel direction.

The threading device is preferably pivotally mounted proximate the first transfer device so that the threading device can be pivoted between an inoperative position and an operative position for directing the tail of the fibrous web from the first transfer device to the second transfer device. In this regard, the threading device can be positioned so that the tail of the fibrous web engages the upper surface of the threading device and is directed therealong via the air cushion such that the tail is directed to the second transfer device. Advantageously, the threading device can be pivoted to the operative position that is defined by a predetermined angle between the threading device and the first transfer device such that the predetermined angle remains fixed during the threading operation. The predetermined angle is dependent upon at least the positions of the first transfer device, second transfer device, and the threading device.

According to one embodiment, a threading operation for transferring the tail of the fibrous web between the first and second transfer devices in a press section of a fibrous web making machine comprises positioning the pivotable threading device to the operative position and directing the tail of the fibrous web from the first transfer device to

the pivotable threading device. The relative dryness of the web as it exits the first transfer device is no more than about 60%, and preferably about 20-50%, which results in a relatively wet, heavy, and sticky web. In this regard, a doctor blade may be positioned proximate the roll of the first transfer device for removing the fibrous web therefrom. The threading operation also includes directing gas, such as air, through respective outlets of the plurality of tubes that define the upper surface of the pivotable threading device so as to provide the air cushion between the upper surface and the fibrous web. The tail of the fibrous web is thereby directed along the air cushion on the upper surface of the pivotable threading device to the second transfer device such that the tail of the fibrous web is threaded thereinto.

Advantageously, the apparatus of the present invention provides a threading device that is operable to thread a relatively wet fibrous web through the press section of a web making machine. The pivotable feature of the threading device allows the threading device to be positioned such that the tail of the fibrous web can be directed from the first transfer device to the second transfer device automatically, which greatly improves threading operation efficiency and safety. As conventional machines are primarily directed towards transferring webs with a much greater level of relative dryness, these conventional machines or devices would likely be unsuitable or inoperative for transferring the relatively heavier and sticker wet webs that are present in the press section in a web making machine. In this regard, the apparatus of the present invention provides a pivotable threading device having a stationary upper surface such that only the air cushion created by the plurality of tube outlets is employed between the upper surface of the threading device and the fibrous web for directing the tail of the fibrous web to the second transfer device. As such, the apparatus of the present invention provides an efficient and safe method of transferring the tail of a relatively wet fibrous web between transfer devices of the web making machine.

BRIEF DESCRIPTION OF THE DRAWINGS

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

Figure 1 is a schematic side view of a press section of a fibrous web making machine according to one embodiment of the present invention;

Figure 2 is a side view of an apparatus for transferring a fibrous web in a press section of a machine for making the fibrous web according to one embodiment of the present invention;

Figure 3 is an enlarged side view of a pivotable threading device according to one embodiment of the present invention;

Figure 4 is a top view of the threading device shown in Figure 3 as seen along lines 4--4; and

Figure 5 is an end view of the threading device shown in Figure 3 as seen along lines 5--5.

DETAILED DESCRIPTION OF THE INVENTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

Figure 1 is a schematic illustration of a press section apparatus **20** of a paper machine. A fibrous web **30** is carried by a forming wire **10** from the forming section to the press section, where it is dewatered by pressing. The web **30** is transferred from the forming wire **10** at a pick-up point **P** onto a press felt **12** on a suction zone **11a** of a pick-up roll **11**. On the pick-up felt **12** the web **30** is transferred into a first dewatering nip **81**, which is formed between a center roll **16** and a lower press roll **14**. The center roll **16** has a polyurethane cover and is blind drilled and grooved. The lower press roll **14** can also be blind drilled and grooved. The first nip **81** is preferably a twin-felt nip, and it includes a lower felt **13** guided by guide rolls **15**.

After the first dewatering nip **81**, the web **30** follows the felt **12** into a second nip **82**, which is formed between the center roll **16** and a first transfer device **22** that includes

a press roll **24**. The press roll **24** has a plain surface. One or more steam boxes (not shown) may be provided to improve dewatering as discussed in U.S. Patent No. 5,120,400, which is incorporated herein by reference. The first transfer device **22** also includes a cutting device **26** for cutting a tail of the web **30**, as discussed more fully below. On the lower sector of the press roll **24** there is a doctor blade **34**, which keeps the surface of the roll clean and detaches the web **30** when it becomes stuck to the roll.

In a normal threaded position (shown in dashed line **32**), the web **30** extends from the press roll **24** to a second transfer device **40**, which includes a suction transfer roll **42** and a paper guide roll **44**. The second transfer device **40** is preferably positioned in the press section of the machine; however, the second transfer device **40** may instead be positioned in the drying section of the machine. The web **30** is fed into a transfer zone **46**, formed by the suction transfer roll **42** and paper guide roll **44**, and onto a press felt **27**, which carries the web on its upper face into other downstream components of a conventional press or drying section, such as a shoe press roll. The possible downstream components are further described in U.S. Patent No. 5,120,400. In the press section described herein, the web **30** has a relative dryness of less than about 60%, and preferably has a dryness of about 20-50%. In this regard, the web **30** is relatively wet, heavy, and sticky, and the physical integrity of the web is much less than a web having a greater percentage of dryness, such as a web found in a drying section of the web making machine.

The press section **20** also includes a threading device **50** that is positioned in a space defined between the first transfer device **22** and the second transfer device **40**, and may be mounted to the same beam as the doctor blade **34**. In one embodiment shown in Figure 2, the threading device **50** includes a main portion **52** that is pivotable about a joint **54**. The threading device can be pivoted between an inoperative position **55**, which allows a portion of the web **30** to fall into a broke pit or the like, and an operative position **56** for use during a threading operation, as discussed more fully below. According to one embodiment, the threading device **50** also includes at least one fixture **58** for operatively connecting to an actuator **48**, such as a fluid-operated cylinder that is known in the art. Other types of devices for pivoting the threading device **50** between the operative position **56** and inoperative position **55** can be used, such as electrical or fluid motors, or

the threading device can by manually pivoted. The threading device also includes an air intake opening **57** for receiving air from a suitable source having a pressure of at least about 70 psi.

When the wet web **30** becomes severed at a point upstream of the second transfer device **40** and a tail **60** of the web is thereafter formed, the web must be threaded from the first transfer device **22** to the second transfer device **40**. In particular, the cutting device **26** is movable (see broken lines) so that the tail can be severed to create a free, leading end that the threading device **50** according to the present invention can more easily pass on to the remainder of the machine. Advantageously, the threading device **50** directs the tail **60** of the web **30** from the first transfer device **22** to the second transfer device **40** despite the low strength and the relatively great weight of the wet web.

In one embodiment, the tail **60** of the web **30** is in contact with press roll **24** of the first transfer device **22** as the roll rotates and moves the web along a path of travel. The web **30** proceeds towards the threading device **50** and preferably is removed by a doctor blade **34**. The tail **60** is then directed to the main portion **52** of the threading device **50** via a guide plate **36**. Preferably, the threading device **50** is adjustable in a direction that is substantially transverse to the path of travel of the web, such as by about 500 mm, so that the threading device is capable of transferring webs of different widths.

Figures 3, 4, and 5 show various views of the threading device **50**. As shown in Figure 3, the main portion **52** of the threading device **50** includes a stationary upper surface **62** and a plurality of tubes **64** that extend substantially transverse to the path of travel of the tail **60** and web **30** during the threading operation. In one embodiment, the tubes **64** are polygonal in shape, such as rectangular, and are adjacent or contiguous to one another to define a substantially continuous upper surface **62**. Each of the tubes **64** includes a tubular body **66** defining an interior **68** that is operably connected to the air intake opening **57**, and each tube includes an outer surface **67** that defines a portion of the upper surface **62** of the threading device **50**. The body **66** also defines a plurality of outlets **70** for discharging air in a direction that is substantially aligned with the path of travel of the web during the threading operation. The outlets **70** of each tube **64** are closely aligned with the body **66** of the next adjacent tube such that the outlets **70** are capable of directing air over the outer surface **67** of the body **66** of the next tube. Thus,

air entering the air intake opening **57** is directed through each of the tubes **64** and out the respective outlets **70** thereof such that an air cushion **72** is provided along the upper surface **62** of the threading device **50**. Advantageously, the air cushion **72** has a pressure lower than the surrounding environment, such that the tail **60** of the web **30** is drawn to and held by the air cushion. The air cushion **72** travels downstream along the upper surface **62** of the threading device **50**, and the tail **60** is drawn along the upper surface therewith. However, the tail **60** and web **30** are also supported by the air cushion such that the web **30** tends to follow the direction of the upper surface **62**, even beyond the most downstream edge thereof, to the second transfer device **40** and is threaded thereinto.

More specifically, a dynamic vacuum in accordance with Bernoulli's law and the Coanda effect is created via the outlets **70** of the tubes **64** that acts on the tail **60**. Due to the presence of the vacuum, the tail **60** is attracted to and carried by the air cushion **72** so that the air cushion carries the tail **60** onwards along the path of travel.

The outlets **70** of the tubes **64** can be of many forms, including a single opening extending substantially the length of the tube, or a plurality of openings spaced apart along the length of the tube **64**. In addition, if multiple openings are defined by each tube **64**, the openings of adjacent tubes can be staggered relative to one another in the transverse direction, or may be aligned in the transverse direction as shown in Figure 5. In either case, preferably all of the openings defining the outlet **70** of each tube are directed substantially in the downstream direction. Angled openings (not shown) could also be present at the ends of the tubes **64**.

After the tail **60** of the fibrous web **30** is removed from the press roll **24** of the first transfer device **22**, the tail is directed to the upper surface **62** of the threading device **50**. The threading device **50** is positioned in an operative position **56** that forms a predetermined angle **A** with the first transfer device **22**. More specifically, the predetermined angle **A** is defined herein as the angle between a vertical plane and a plane extending parallel to the upper surface **62** of the threading device **50**. The predetermined angle **A** and the operative position **56** of the threading device **50** are determined by at least the relative positions of the first transfer device **22**, second transfer device **40**, and the gap defined therebetween. Other factors may also be considered, such as air velocity

of the air cushion **72** or the physical characteristics of the web **30** including velocity, basis weight, and dry solids content.

During the threading operation, air is directed into the air intake opening **57** and through the tubes **64** such that the air cushion **72** is created along the upper surface **62**. The tail **60** of the web **30** is directed to the upper surface **62** and is drawn to the air cushion such that the tail advances along the upper surface **62** and is supported by the air cushion **72**. The tail **60** is then directed to the second transfer device **40** and, more particularly, is threaded into the transfer zone **46** of the second transfer device. The tail **60** is then drawn into the transfer zone **46** by the suction transfer roll **42** and paper guide roll **44** of the second transfer device **40** so that the web **30** transfers back to the normal position **32** between the first transfer device **22** and the second transfer device.

Many modifications and other embodiments of the invention will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.